
9. Conclusions

This document presents the Stage I Injury Assessment of hazardous substance releases, pathways, and injuries in the KRE as a part of the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site NRDA being conducted by federal and state natural resource Trustees. The Stage I Assessment was conducted according to the Stage I Assessment Plan prepared by the Trustees (Michigan Department of Environmental Quality et al., 2000b). The purpose of the Stage I Injury Assessment is to develop preliminary conclusions regarding the nature and extent of natural resource injuries resulting from hazardous substance releases into the KRE. The Stage I Assessment is intended to be preliminary and based primarily on existing data. The results of the Stage I Assessment will be used by the Trustees to help define any additional focused work that could be conducted in the next stage and, if appropriate, to help evaluate any potential settlement options.

Table 9.1 presents a summary of the Stage I Injury Assessment conclusions. For each resource and injury definition, the table presents the conclusions of the Stage I Injury Assessment using the following terms:

- ▶ “Yes,” meaning that available data demonstrate that the injury in question has occurred
- ▶ “No,” meaning that available data demonstrate that the injury in question has not occurred
- ▶ “Possibly,” meaning that there is some available data demonstrating that the injury in question has occurred, but important uncertainties remain
- ▶ “Unknown,” meaning that the available data are not sufficient to demonstrate that the injury in question either has or has not occurred.

The spatial extent of injuries to resources is described in terms of the KRE Assessment Area, which includes the natural resources within the Portage Creek and Kalamazoo River riparian corridors and in Lake Michigan that are exposed to hazardous substances released from the PRP facilities.

Table 9.1. Summary of Stage I Injury Assessment conclusions

Resource	Injury definition evaluated	Injured?	Spatial extent (if injured)	Notes
Surface water/ sediment	PCBs in excess of drinking water standards	No		
	PCBs in excess of aquatic life standards/criteria	Yes	All of Portage Creek and Kalamazoo River downstream of PRP facilities	
Fish	PCB fish consumption advisories	Yes	Entire assessment area	
	PCBs in excess of FDA tolerance level	Yes	All of Portage Creek and Kalamazoo River downstream of PRP facilities	
	Adverse reproductive effects	Possibly	Only selected Kalamazoo River locations sampled, extent unknown	Uncertainty regarding toxicity benchmarks.
	Sublethal adverse toxicological effects on smallmouth bass	Possibly	Only selected Kalamazoo River locations sampled, extent unknown	Definitive causal link between observed effects and PCBs not established.
	Sublethal adverse toxicological effects on other fish	Unknown		
Benthic invertebrates	Adverse toxicological effects from surface sediment PCBs	Yes	All of Portage Creek and Kalamazoo River downstream of PRP facilities	
Waterfowl	PCBs in excess of FDA tolerance level	Unknown		Limited (and contradictory) data.
Bald eagles	Adverse reproductive effects from PCBs	Yes	Entire assessment area	Two breeding areas in Allegan State Game Area, and one near New Richmond. Depending on suitability of habitat, rest of river downstream of PRP facilities.
Other piscivorous or carnivorous bird species	Adverse reproductive and sublethal effects from PCBs	Possibly	All of Portage Creek and Kalamazoo River downstream of PRP facilities	High PCB exposure, but sensitivity of these birds to PCB toxicity is unknown.

Table 9.1. Summary of Stage I Injury Assessment conclusions (cont.)

Resource	Injury definition evaluated	Injured?	Spatial extent (if injured)	Notes
Passerine birds	Adverse toxicological effects from PCBs	Unknown		Sensitivity of these birds to PCB toxicity is unknown.
Mink	Adverse reproductive effects from PCBs	Yes	All of Portage Creek and Kalamazoo River downstream of PRP facilities	Multiple lines of evidence with consistent conclusions.
Mice, fox	Adverse toxicological effects from PCBs	No		
Muskrat, shrew	Adverse toxicological effects from PCBs	Unknown		Limited data; sensitivity to PCB toxicity is unknown.
Floodplain soils	PCBs in soil predicted to cause adverse effects to biota	Yes	Former impoundments and other areas along the Kalamazoo River	
Molluscs	Adverse community-level effects	Indirect	Impounded areas of the Kalamazoo River	Habitat limited by dams which would otherwise be removed.
Various	Adverse aquatic habitat effects	Indirect	Kalamazoo River areas downstream of former impoundments	Habitat effects from dams that would otherwise be removed.
Various	Indirect injuries from response actions	Unknown (actions not yet selected)	Dependent on location of remedy implementation	Remedy not yet selected, so nature and type of indirect injuries is unknown.

More specifically, the analyses presented in this document support the following Stage I Assessment conclusions:

- ▶ PCBs were released from PRP facilities into the KRE.
 - Carbonless copy paper containing PCBs was manufactured from 1954 to 1971. Between 1957 and 1971 over 44 million lbs of PCBs (as Aroclor 1242 and Aroclor 1254) were used in the production of carbonless copy paper across the country. An estimated 20% of this paper (or approximately 8.8 million lbs of PCBs) was recycled at various mills across the country, including those of Allied, Georgia-Pacific, Simpson Plainwell, and Fort James (now owned by Georgia-Pacific) in the KRE.

- The waste stream from PRP facilities was highly contaminated with PCBs. PCBs were detected in effluent and other discharges from facilities, in residuals, and in groundwater. The total contribution of PCBs released by Allied, Georgia-Pacific, Simpson Plainwell, and Fort James facilities into the KRE has been estimated as between 2.2 and 4.4 million lbs (1 and 2 million kg). Releases from PRP facilities are the predominant source of PCBs in the KRE.
- PCBs released from the PRP facilities into the KRE have migrated downstream via surface water pathways. An estimated 36.8 kg (81.1 lbs) of PCBs are contributed annually to Lake Michigan from the Kalamazoo River. Other PCBs have been deposited in instream sediment and in floodplain sediment and soils of Portage Creek and the Kalamazoo River. PCBs are generally persistent in the environment and degrade very slowly.
- ▶ KRE surface water has been and is injured as a result of PCB releases.
 - Surface water PCB concentrations downstream of PRP facilities in Portage Creek and the Kalamazoo River exceed applicable water quality criteria established by the State of Michigan and EPA for human cancer risk, and for the protection of aquatic life and piscivorous wildlife. Based on the sources and timing of the releases, it is highly unlikely that PCBs would have been present before the initial release in the mid-1950s and thus it is reasonable to conclude that water did not exceed these criteria before this time. Additionally, the Kalamazoo River and Portage Creek have designated committed uses that are relevant to the exceedence of water quality criteria. The exceedences of relevant criteria and standards occurs throughout the length of Portage Creek and the Kalamazoo River downstream of PRP facilities, and have most likely occurred beginning soon after PCBs were incorporated into the facilities' waste streams.
 - PCB concentrations in surface water are sufficient to cause injury to fish and benthic invertebrates that are exposed to the surface water (described in subsequent bullets).
- ▶ KRE sediment has been and is injured as a result of PCB releases.
 - PCB concentrations in surface sediment of Portage Creek and the Kalamazoo River downstream of PRP facilities are nearly three orders of magnitude greater than a consensus-based extreme effect concentration above which toxicity to benthic invertebrates is expected to occur.

- PCB concentrations in surface sediment are sufficient to have caused injury to mink based on food chain dietary exposure. Concentrations are as high as three orders of magnitude greater than a site-specific LOEL for mink.
- Available data indicate that injuries to sediments occur throughout Portage Creek and the Kalamazoo River downstream of PRP facilities.
- ▶ KRE fish have been and are injured because of fish consumption advisories issued in response to the PCB releases.
 - PCB fish consumption advisories have been issued since 1979. PCB concentrations in edible tissue for many species have been greater than the trigger levels for advisories as directed by the State of Michigan. Advisories downstream of PRP facilities are more severe and apply to more species than advisories upstream of PRP facilities.
 - PCB concentrations in fish tissue downstream of PRP facilities have also exceeded tolerance levels established by the FDA under the Food, Drug and Cosmetic Act.
 - Areas of fish consumption advisory injuries are the Kalamazoo River from Morrow Dam to Lake Michigan, Portage Creek, and portions of Lake Michigan. Concentrations of PCBs have been sufficient to trigger advisories or exceed tolerance levels since the early 1970s, and exceedences are likely to continue into the future.
- ▶ Smallmouth bass in the KRE may be (and may have been) injured as a result of PCB releases.
 - Available data on TCDD-eq concentrations from PCBs in smallmouth bass and walleye eggs generally do not support the conclusion that recent PCB concentrations are sufficient to cause adverse reproductive injuries in these fish. However, a LOEL from the single chronic laboratory exposure study available demonstrate that KRE fish may be suffering from chronic reproductive injuries. The applicability of the chronic exposure study is difficult to assess.
 - PCB concentrations in many KRE smallmouth bass livers are less than available literature toxicity thresholds for sublethal effects. However, few literature thresholds are available, and KRE bass liver PCB concentrations are comparable to concentrations observed in fish from the Lower Fox River/Green Bay (Wisconsin) that had increased incidences of liver tumors and pre-tumors.

- A limited, preliminary study of KRE smallmouth bass showed that bass collected from the assessment area had higher PCB concentrations and significant alterations of body condition, endocrine function, and histopathological status compared to those collected in upstream reference areas. The types of biochemical responses and histopathological observations were consistent with those seen in other sites where freshwater fish have been exposed to PCBs. However, a definitive causal relationship could not be established given the study design.
- ▶ Data are not available to evaluate adverse toxicological effects injuries to other fish species.
- ▶ Benthic invertebrates have been and are injured by exposure to PCBs in surface sediments that exceed toxicological thresholds for adverse effects. Concentrations in surface sediments from all of Portage Creek and the Kalamazoo River downstream of PRP facilities exceed thresholds.
- ▶ It is unknown whether waterfowl are injured due to of exceedences of the FDA tolerance level for poultry because of minimal (and contradictory) available data on PCB concentrations in edible tissue.
- ▶ Bald eagles have been and are injured as a result of PCB releases.
 - Bald eagles have dramatically decreased reproductive rates in the Kalamazoo River compared to nesting success in other known PCB contaminated areas and to coastal and inland Michigan averages. The average nesting success between 1990 and 2003 was only 0.2 young per nest, far below normal replacement rates.
 - Failed bald eagle eggs collected in the Kalamazoo River assessment area contain PCB concentrations that are sufficient to cause reproductive effects.
 - Bald eagle nestling plasma samples contain PCB concentrations that are sufficient to cause reproductive effects.
 - The MDEQ ERA concludes that risks to bald eagles from dietary PCB exposure are high. PCB concentrations in KRE fish, a primary bald eagle food item, exceed thresholds for dietary toxicity.
 - Injury to bald eagles dates back to at least 1990, when the first nest was attempted in the Kalamazoo River, and continues to the present day. It is possible that nest failure would have occurred earlier than this, but it appears that no nests were attempted along the Kalamazoo River between 1960 and 1989.

- ▶ Other avian species in the KRE may be (and may have been) injured as a result of PCB releases.
 - Eggs of eastern bluebird, great blue heron, house wren, great horned owl, and red tailed hawk contain concentrations of PCBs that exceed relevant toxic thresholds for reproductive effects.
 - Concentrations of PCBs in eggs of various KRE bird species, including mute swan, robin, tree swallow, red-winged blackbird, and wood duck are within or exceed the range associated with embryomortality effects in sensitive species. However, the sensitivity of these species to PCB toxicity is unknown.
 - PCB concentrations in KRE fish exceed thresholds for dietary toxicity to piscivorous birds.
- ▶ KRE mink have been and are injured as a result of PCB releases.
 - PCB concentrations in KRE fish exceed dietary thresholds for causing adverse reproductive impacts to mink.
 - PCB concentrations in mink tissue (whole body and liver) exceed concentrations associated with reproductive effects.
 - Mink trapping success is lower in the KRE downstream of PRP facilities compared to a reference location. Although the trapping study was not designed to evaluate mink abundance, the results suggest a lower abundance of mink in PCB contaminated areas.
 - The MDEQ ERA concluded that mink are at risk from dietary exposure pathways.
- ▶ Other mammalian species and shrews in the KRE may be (and may have been) injured because of PCB exposure.
 - The MDEQ ERA concluded that other mammalian species such as mice and muskrat are not at risk from dietary exposure pathways. Red fox is unlikely to be at risk from dietary exposure pathways.
 - PCB concentrations in small mammals are lower than or similar to toxicity thresholds for mink, a more sensitive species, and thus small mammals do not appear to be injured.

- PCB concentrations in some shrews are higher than toxicity thresholds for mink. However, the sensitivity of shrews to PCB toxicity is unknown, and thus injury to shrews is uncertain.
- Total PCBs in muskrat livers are elevated downstream of PRP facilities, and concentrations in some samples exceed the reproductive effects TRV for mink. Total PCBs in whole body muskrat do not exceed the whole body reproductive effects TRV for mink. Further analysis would be required to draw conclusions regarding injury to muskrat.
- ▶ Floodplain soils in the KRE have been and are injured because of PCB contamination.
 - PCB concentrations in surface floodplain soils exceed site-specific thresholds corresponding with adverse effects to robin and great horned owl via food chain exposure. Exceedences are of the greatest magnitude and frequency in soils of the former impoundments.
- ▶ Indirect injuries to resources have been occurring and may continue to occur as a result of response actions taken to address PCB contamination in the KRE.
 - Because of the presence of PCBs in sediments stored behind them, several dams along the Kalamazoo River that were targeted for removal have remained in place. As a result, the aquatic habitat has been injured. Mussel populations are adversely affected in areas behind the dams, and other resources have been affected as well.
 - Future indirect injuries may be caused by PCB response actions. At this time, remedial actions for the Kalamazoo River have not been selected by the response agencies. The nature and extent of indirect injuries and natural resource service losses will vary depending on the remedial actions that are implemented. The Trustees are coordinating with the EPA and MDEQ Superfund Section to minimize indirect injuries associated with the remedial options and will consider any indirect injuries associated with remedial actions in future stages of the NRDA.